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BIOLOGY AND IMMATURE STAGES OF *OCHROTRICHIA QUADRISPINA* DENNING AND BLICKLE (TRICHOPTERA: HYDROPTILIDAE), A SPRING-INHABITING SCRAPER

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Abstract.—Larvae of *Ochrotrichia quadrispina* Denning and Blickle were obtained from a spring adjacent to the high tide line of a southern California beach. The spring created a madicole over exposed bedrock within which larvae grazed periphyton. Although the filamentous chlorophyte *Cladophora* was present, no larvae consumed this alga during observations of all instars in the laboratory. Gut contents analysis showed that unicellular algae, detritus, and mineral materials were consumed in the field. Final instars constructed cases of a single convex dome with a flexible silken ventral valve that sealed the case when larvae were withdrawn. Morphological descriptions of the five instars are given.

Key Words: *Ochrotrichia*, microcaddisflies, aquatic insects, larvae, madicoles

Microcaddisflies (Trichoptera: Hydroptilidae) are known from lentic and lotic freshwater habitats (Wiggins 1996a). Larvae of the genus *Ochrotrichia* Mosely appear to be associated with flowing water (Ross 1944). Most species of this genus feed by scraping periphyton, although some species, such as *O. xena* Ross, consume the liquid contents of cells within filaments of green algae (Chlorophyta) (Wiggins 1996b, Keiper and Foote 1998). Vaillant (1984) described the morphology and gave biological observations of the mature larvae of *O. confusa* found in a madicolous (i.e., dripping rock) habitat; he mentioned that *O. quadrispina* inhabits these shallow waters as well. Although the larva of the latter species was not described, Vaillant (1984) mentioned that slight morphological differences between the two exist. Herein, we describe the early and mature larvae of *O. quadrispina* and give biological observations acquired during laboratory rearings.

Materials and Methods

Larvae of *O. quadrispina* were collected in June from a spring flowing over a bedrock outcropping at the ocean-side base of sand dunes approximately 500 m south of South Carlsbad Beach (CA, San Diego Co.). This freshwater habitat was situated 1–2 m vertically from the debris wrack created by the Pacific Ocean high tides. The water emanated from a seepage area within a dense stand of cattails (*Typha* sp.), was less than 0.5 cm deep, and formed a few pools of water in shallow concavities.

Examination of the substrate revealed diatoms, unidentified unicellular green algae (Chlorophyta), long filaments of *Cladophora* sp. (Chlorophyta), short cyanobacterial filaments, and miscellaneous detrital and mineral particles. *Odontomyia* sp. (Diptera: Stratiomyidae) larvae were abundant throughout the spring, and *Hydropsyche* (Trichoptera: Hydropsychidae) larvae and Hydrophilidae (Coleoptera) larvae and

adults were occasionally encountered. Larval and pupal *O. quadrispina* were placed in jars of field-collected spring water, and put in a cooler along with *Cladophora* and pieces of diatom-covered bedrock for transport back to the laboratory. Adult specimens were taken from dead *Typha* stems hanging over the bedrock.

Immature stages were separated into pupae, fifth instars, and early instars (1–4), and each group was placed separately into small (2.5 cm diameter) Petri dishes, along with water and field-collected materials. Early instars were determined based on qualitative appearance recognizable from experience working with Hydroptilidae, and confirmed using Dyar's Rule (Dyar 1890, Richards and Davies 1977). Dishes were placed near a window to maintain a natural photoperiod, and the temperature in the laboratory was maintained at ~20° C. Water was changed every 3–4 days.

Some specimens were killed in near-boiling water, fixed with Kahle's fluid, and preserved in 70% ethanol following the methods of Wiggins (1996a). Gut contents analyses of field-collected fifth instars (n = 6) were performed by dissecting the guts from fixed specimens and mounting on slides. Larval behavior was observed with a Wild MZ8 dissecting microscope, with the light source set on the lowest intensity needed for observation to reduce the possibility of disturbance.

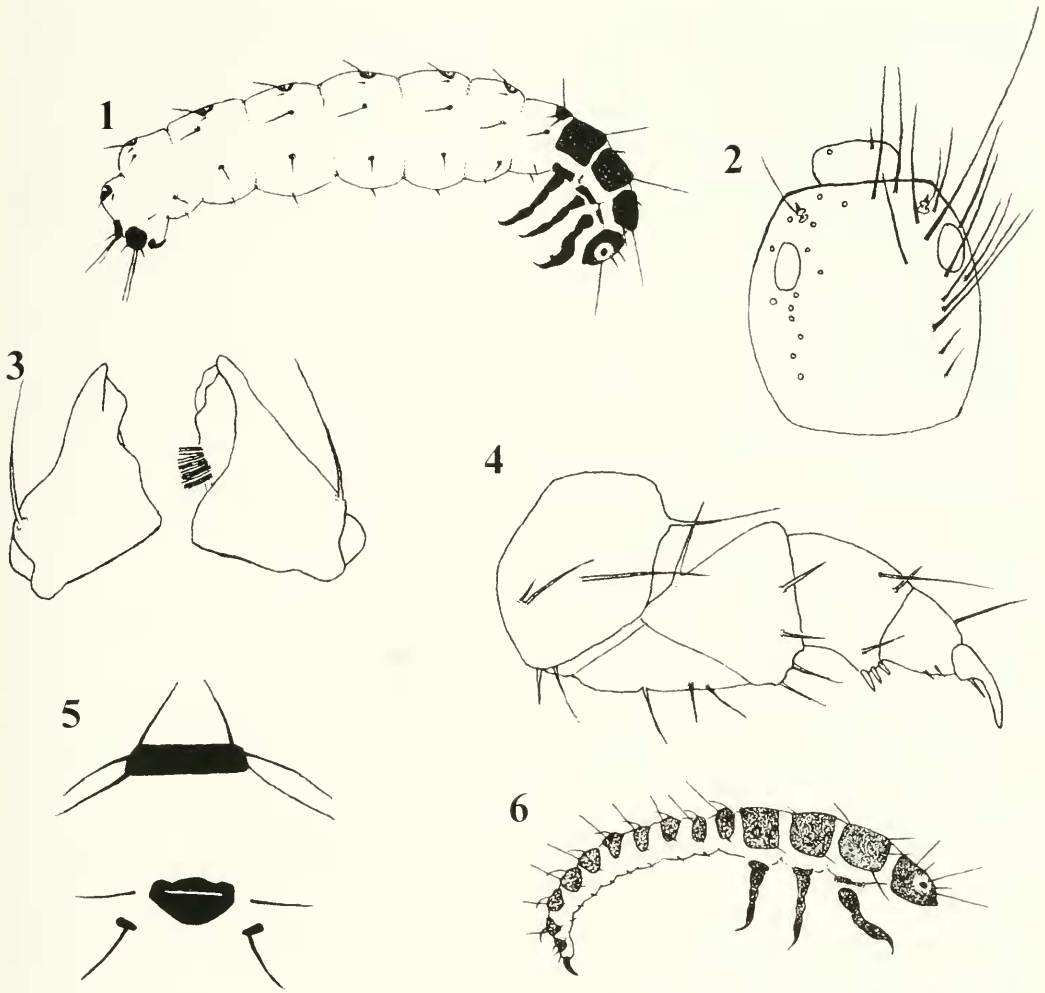
Morphological description of larvae followed the methods described by Keiper and Foote (1999). Only field-collected larvae were used for description, as efforts to obtain viable eggs from field-collected females were unsuccessful, and few early instars were collected in nature. Therefore, only one larva for each early instar was described; measurements and descriptions of fifth instars are based on six larvae.

Results

Final (5th) instar.—Length 2.39–2.63 ($\bar{x}$ = 2.48 ± 0.13) mm. Head: width 0.21–0.22 ($\bar{x}$ = 0.21 ± 0.01) mm; uniformly dark brown to black, without muscle scar pattern, with pale ring around black eye spot (Fig. 1); position of primary setae as in Fig. 2; long seta near eye approximately 1.5× length of head; anterior edge of labrum slightly convex in dorsal view; antenna short, with broad base, bearing long seta 5× length of antenna, flagellum 3 segmented; each mandible bearing one seta on posterolateral corners (Fig. 3), asymmetrical, with right pointed and left bearing coarse teeth and fine setae. Thorax: uniformly dark brown; anterolateral lobes not well developed; two prosternal sclerites, posterior margin of each with a short pointed lobe. Prothoracic leg as in Fig. 4; tarsal claw somewhat curved, basal seta approximately half the length of claw; tarsus with one dorsal seta approximately the length of claw; venter of tibia with strong projection bearing four stout setae (only three visible in lateral view); femur with two strong setae ventrally and one dorsally; minute secondary setae present on all segments. Abdomen: milky white and translucent, primary setae as in Fig. 1; dorsomedial sclerite of first segment roughly rectangular, with 3 well-developed setae laterally (Fig. 5); dorsomedial ring-like sclerites on segments 2–8 dark brown (Fig. 5); sclerite sa2 elliptical, bearing one strong seta; sclerite sa3 roughly circular, small, bearing one small seta; dorsal sclerite of segment 9 rectangular, with anterior margin convex, bearing 3 strong posterior setae, middle pair approximately 2–3 times length of others; sclerites of abdominal segment 10 and prolegs typical of *Ochrotrichia* (Wiggins 1996a).

Case.—Tortoise-shell type (Wiggins 1996a), constructed from tiny mineral particles; dorsal peak of upper valve skewed slightly in transverse cross section; lower valve lacking particles; resembles dome case illustrated by Wiggins (1996a).

Early instars flattened dorsoventrally, with uniformly brown sclerites on thoracic and abdominal segments, darkening with age; non-sclerotized areas milky white; setae well developed. Anal prolegs with long



Figs. 1–6. *Ochrotrichia quadrispina*. 1, Fifth instar, lateral view. 2, Head of fifth instar, dorsal view. 3, Mandibles of fifth instar, ventral view. 4, Right foreleg of fifth instar. 5, Dorsomedial sclerite, first abdominal segment (top), and dorsomedial ring sclerite of second abdominal segment (bottom), fifth instar. 6, Third instar, lateral view.

apical claw. Differences among early instars mainly a matter of proportion. Instars 1–4 free-living, never constructing cases.

First instar.—Length 0.42 mm. Head: width 0.05 mm; uniformly light brown, translucent, no evidence of ring around black eye spot. Thorax same color as head capsule. Abdomen sclerites same color as head capsule. Second instar—Length 0.55 mm. Head: width 0.09 mm; uniformly light brown, slightly darker than first instar, translucent, no evidence of ring around black eye spot. Third instar—Length 0.72 mm. Head: width 0.12 mm; uniformly light brown, slightly darker than second instar, with inconspicuous pale ring around black eye spot (Fig. 6). Fourth instar—Length 1.04 mm. Head: width 0.19 mm; uniformly brown (somewhat lighter than fifth instar), with definite pale ring around black eye spot.

Early instars were found almost exclusively in the masses of *Cladophora* collected from the madicole. The algal micro-

habitat probably represents refugia and a foraging area for the small larvae. During observations of feeding in the laboratory, larvae crawled across the rock substrate, and rapidly abducted and adducted their mandibles in an apparent effort to graze the periphyton present; their guts became dark brown. Some larvae, particularly later instars (3–4), moved among filaments of *Cladophora* and grazed the epiphytes growing on the cell walls. At 50×, we observed larvae scraping diatoms and unicellular chlorophytes scattered on the cell walls with the rapid action of the mandibles.

The fifth instars fed in a manner similar to that of the early instars. Larvae grazed the substrates with their mandibles held perpendicular to, or nearly parallel with, the cell walls or rocks. When perpendicular to the substrates, the distal tips of the mandibles macerated diatomaceous substrates or exploited small concavities. Larvae often shifted the position of their mandibles, and placed them nearly parallel to the substrate so the inner margins scraped the periphyton. The setation on the inner margins probably aided in brushing the scraped materials into the mouth (cf., Cummins and Merritt 1996). Fifth instars were observed only on rock substrates in the field, and never among the filaments of algae. Gut contents analyses showed that diatoms, unicellular green algae, and miscellaneous detrital and mineral particles were consumed.

Newly-molted fifth instars initiated case construction by fashioning small rings of material around their abdomens. After approximately 24 hours, the cases resembled completed ones, except that they were roughly the same length as the larva; cases were completed in 3–4 days. Upon withdrawing into the case, mechanical tension caused the silk sheet of the lower valve to become contiguous with the upper valve occluding the opening; the flexibility of the lower sheet allowed larvae to extrude their head and thoracic segments for feeding or movement. Larvae that fully withdrew into their cases appeared to have a silken guyline (cf., Nielsen 1948, Wiggins 1996a) attached to the substrate to help maintain their position in the current.

In the field, pupal cases were often scattered individually on the bedrock surface. However, many aggregations were formed by up to 15 individuals situated side-by-side or end-to-end. Examination of these cases, as well as those individuals which pupated in the laboratory, showed that only the upstream end of the case was attached to the substrate; cases were therefore positioned at a shallow angle relative to the substrate when viewed laterally, and were oriented parallel to the flow of the madicole. The duration of the pupal stage was 9–10 days under laboratory conditions (n = 3).

Discussion

To our knowledge, there have been no published descriptions of the early instars of *Ochrotrichia* spp. The early instars of *O. quadrispina* have dark sclerites, whereas larval *O. wojcickyi* Blickle are colorless during the first two stadia, and only the thoracic sclerites and head capsule darkened slightly during the third and fourth stadia (Keiper 1998). More information on early instars is needed before further morphological comparisons between species can be made.

Ross (1944) provided brief descriptions of and a key to seven *Ochrotrichia* spp. final instars; *O. quadrispina* keys to *O. riesi* based on the presence of dark dorsomedial sclerites with a transverse membranous center on abdominal segments 2–8, as does *O. confusa* (Vaillant 1984). These three species can be separated based on the shape of the dorsomedial sclerites; the anterior edge is produced forming a triangular point in *O. confusa* contrasting the pointed posterior edge of *O. quadrispina,* and the anterior and posterior edges are truncated on *O. riesi.* The dorsomedial sclerites of other species form a small, membranous ring (Ross 1944, Flint and Herrmann 1976, English and Hamilton 1986, Keiper, in press). Mandible morphology also appears to be a use-

ful character for separating species because dentition, presence or absence of bristles on the inner edges, and number of setae on the posterolateral corners varies among those species for which this information is available (Vaillant 1984, English and Hamilton 1986, Keiper and Foote 1998, Keiper 1998, in press). Morphology of dorsomedial abdominal sclerites and mandibles appear distinct among species suggesting that the eventual compilation of larval keys to species is possible, and preliminary efforts indicate that other characters such as prothoracic sclerite shape and sclerite coloration may prove useful.

Gut contents analysis showed that a wide variety of periphytic materials were consumed by larvae. Although species of the hydroptilid genera *Dibusa* Ross (Resh and Houp 1986), *Hydroptila* Dalman, and *Oxyethira* Eaton (Keiper et al. 1998) appear quite specialized in their food preferences, *O. quadrispina* is a generalist consumer of periphyton.

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